* Cavity Resonator :-

→ Cavity resonatur is a metallic encloser formed by shorting two ends of a section of a wave~~length~~guide that exhibits resonance behaviour

→ Cavity resonatur confines the electromagnetic energy.

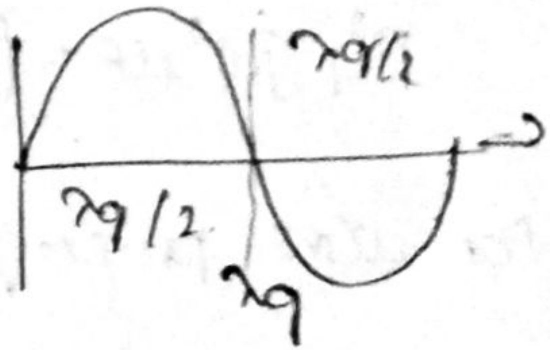
→ The stored electric and magnetic field components inside the cavity determines the equivalent inductence and capacitance.

Application :-

cavity Resonators mainly used in oscillatur tuned amplifiers, filters, Frequency meters and phase Equalizers.

* Based on the length of the cavity the resonance frequency will depend (induced frequency)

1. Rectangular cavity.
2. Circular cavity.



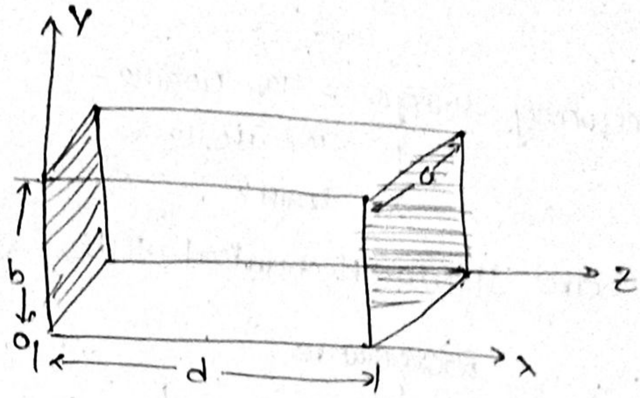
* For Rectangular Cavity Resonator :-

* Resonance Frequency :

$\gamma = \alpha + j\beta$

γ = propogation constant
α = Attenuation constant
β = phase constant

...wavelength.



* The total electric and magnetic energy is stored inside the cavity Resonant.

* The metalic walls and dielectric material inside the resonant of wall cause the losses in the cavity resonator.

* The circuit resonates at tuned frequency where average electric energy and average magnetic energy are equal and impedance becomes purely real.

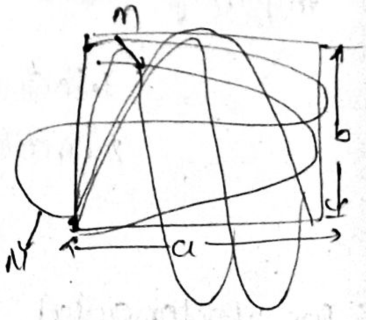
* Since we know that $\boxed{h^2 = \gamma^2 + j\omega^2\mu\varepsilon} \longrightarrow ①$

and also

$$h^2 = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 \longrightarrow ②$$

=> From ① & ②

$$\gamma^2 + j\omega^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2$$



=> For wave propogation

$$\gamma = \alpha + j\beta$$

=> Neglect Attenuation constant.

$$\gamma = j\beta$$

$$\gamma^2 = -\beta^2 \longrightarrow ③$$

From eq ③

$$-\beta^2 + j\omega^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2$$

$$j\omega^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \beta^2 \longrightarrow (C)$$

* If a wave has to exist in a cavity resonator there must be face change corresponding to a given guide wavelength.

i.e., $\beta = \frac{2\pi}{\lambda g}$.

* The condition for the resonator to resonant these.

$$\boxed{\beta = \frac{p\pi}{d}}$$

where p = Halfwave variations along z-axis.
d = length of the resonant.

=> Sub β in eq C

$$j\omega^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{2\pi}{\lambda g}\right)^2$$

$$j\omega^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2$$

Resonane condition :-

=> Frequency $\omega = \omega_0 = 2\pi f_0$

$$j\omega_0^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2$$

$$j(2\pi f_0)^2\mu\varepsilon = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2$$

$$f_0^2 = \left(\frac{1}{\mu\varepsilon j 2\pi}\right)\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2$$

$$f_0 = \sqrt{\frac{1}{2\pi^2\mu\varepsilon j}}\left[\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2\right]^{1/2}$$

$$f_0 = \frac{1}{2\pi\sqrt{\mu\varepsilon}} = \left[\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2\right]^{1/2}$$

$\mu = \mu_0$, $\varepsilon = \varepsilon_0$, $\frac{1}{\pi\sqrt{\varepsilon_0\mu_0}} = c$

$$f_0 = \frac{c}{2}\left[\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2\right]^{1/2}$$

$$\boxed{f_0 = \frac{c}{2}\left[\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 + \left(\frac{p\pi}{d}\right)^2\right]^{1/2}}$$

* General mode of propogation is TE_{mnp} and TM_{mnp}.

* For both TE and TM the resonant frequency is same.